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(71) Applicant: SANDVIK AB [SE/SE]; S-811 81 Sandviken (SE).

(72) Inventor: SILVER, Bengt; Haeffnersvägen 24, S-129 38 Hägersten (SE).

(74) Agent: BENTON, Richard; Sandvik AB, Patent Department, S-811 81 Sandviken (SE).

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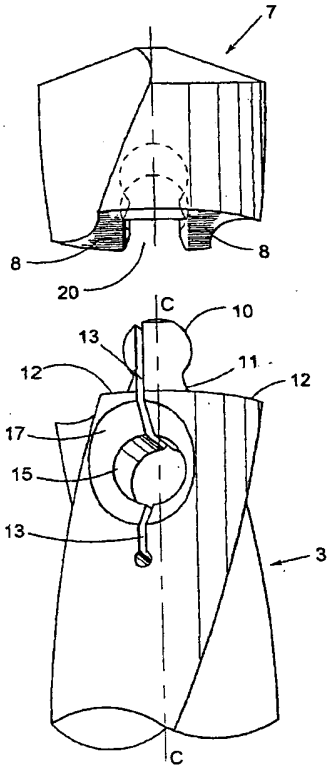
(54) Title: ROTATABLE TOOL HAVING A REPLACEABLE CUTTING PART AT THE CHIP REMOVING FREE END OF THE TOOL



(57) Abstract: The present invention relates to a rotatable tool having a replaceable cutting part (7; 7') at the chip removing free end of the tool, the tool also comprising a tool part (3; 3'), on which the cutting part (7, 7') is intended to be mounted, that tool part (3; 3') and the cutting part (7, 7') have chip channels (9), that the cutting part (7, 7') has member for chip removing machining, and that the tool part (3; 3') and the cutting part (7, 7') are interconnected by means of a dovetail coupling which comprises a male part (10; 10') and a female part (20; 20'). The invention also relates to the cutting part separately. Preferably, the invention relates to a drill or a milling cutter. Characteristic of the tool according to the present invention is that the dovetail coupling comprises members for providing a mutual clamping of the parts (10, 20; 10', 20') included in the dovetail coupling.

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ROTATABLE TOOL HAVING A REPLACEABLE CUTTING PART AT THE CHIP REMOVING FREE END OF THE TOOL

Technical Field of the Invention

The present invention relates to a rotatable tool having a replaceable cutting part at the chip removing free end of the tool, the tool also comprises a tool part, on which the cutting part is intended to be mounted, that the tool part has helicoidal or straight chip channels, that the cutting part has a member for chip removing machining, and that the tool part and the cutting part are interconnected by means of a dovetail coupling which comprises a male part and a female part. The invention also relates to the cutting part separately. The invention relates especially to a drill or a milling cutter.

Prior Art

A twist drill having a replaceable cutting part is previously known from DE-PS 367010 the cutting part being connected to one of the ends of the drill shank by means of a dovetail coupling. The connection between the cutting part and the shank is entirely based on frictional forces between cooperating surfaces of said parts, and therefore there should be an obvious risk that the cutting part may be dislodged from the correct position thereof during handling of the drill.

A drill having a replaceable cutting part is previously known from US-A-5 904 455. The cutting part is fixed in a recess in the front end of the drill by a clamping action of the sides of the recess abutting against the cutting part. This clamping action may be provided by inherent elasticity of the material forming the recess, or alternatively the clamping action may be enhanced by applying an axial force to the cutting part, by a suitable design of the bottom of the recess and the portion of the cutting part abutting there against a

compressing force being generated on the cutting insert by the sides of the recess.

Aims and Features of the Invention

A primary aim of the present invention is to describe a tool of the kind defined above where the fixation of the replaceable cutting part takes place in an exceptionally simple but yet reliable manner.

Yet another aim of the present invention is that the cutting part, i.e. the article which is consumed, should be design-wise exceptionally simple.

An additional aim of the present invention is that when assembling the cutting part on the tool part, it should in practice be impossible to assemble the cutting part in the wrong way and that the cutting part in principle automatically takes up a correct position in relation to the tool part.

At least the primary aim of the present invention is realised by means of a tool having the features defined in the subsequent independent claim 1. Preferred embodiments of the invention are defined in the dependent claims.

Brief Description of the Drawings

Below embodiments of the invention will be described, reference being made to the accompanying drawings, where:

Fig 1 shows a perspective view of a first embodiment of a drill according to the present invention;

Fig 2 shows on a larger scale an exploded view of a part of the drill according to the present invention positioned closest to the tip, the cutting part being separated from the rest of the drill;

Fig 3 shows a planar view of the tool part included in the drill according to the present invention;

Fig 4 shows a section along A-A in Fig 3 through the tool part as well as a corresponding cross-section through the cutting part;

Fig 5 shows in detail co-operating surfaces of the male part and the female part in the dovetail coupling; and

Fig 6 shows schematically an alternative embodiment of a dovetail coupling.

Detailed Description of Preferred Embodiments of the Invention

The drill 1 illustrated in Fig 1 comprises a tool part 3 as well as a shank 5, which is intended to be received in a machine tool. The drill 1 also comprises a replaceable cutting part 7 which is attached to the end of the tool part 3 turned away from the shank. The cutting part 7 is provided with a member for chip removing machining, which, however, is not specifically shown in Fig 1. Helicoidal chip channels 9 are formed on the circumference of the tool part 3. Said chip channels 9 also extend into the circumference of the replaceable cutting part 7.

As is most clearly seen in Fig 2, the cutting part 7 is connected to the tool part 3 by means of a dovetail coupling. In the embodiment illustrated in Figs 1-5, the dovetail coupling comprises a male part 10, which constitutes an integrated part of the tool part 3. The male part 10 has an extension in the longitudinal direction thereof, equalling the major part of the diameter of the tool part 3, see Fig 4. However, the left end in Fig 4 of the male part 10 is displaced a distance from the periphery of the tool part 3, the significance of this design will be explained below in connection with the description of the function of the dovetail coupling. In end view, see Fig 2, the male part 10 has a generally circular shape with a portion 11 connecting to the tool part 3 which has a smaller transverse dimension than the maximum transverse dimension of the cross-section. The male part 10

has, in the main, constant external dimensions along the entire longitudinal direction thereof. A first support surface 12 surrounding the male part 10 is plane, said first support surface 12 not being perpendicular to the longitudinal direction of the tool but forming an obtuse angle α to a first, axially extending, centre plane B-B of the tool part 3 and the cutting part 7, which centre plane B-B extends perpendicularly to the paper in both Fig 3 and 4. Preferably, the angle α is of the order of 100°. A suitable interval for the angle α is: $90° < \alpha < 120°$. A longitudinal centre axis 4 of the male part 10 forms the corresponding angle α to the centre plane B-B.

As is seen in Figs 2 and 3, a slot 13 is recessed in the tool part 3 and the male part 10. The slot 13 is situated in a plane, which has an extension in the axial direction of the tool part 3. As for the extension of the slot 13 in the radial direction of the tool part 3, this is seen in Fig 3. Thus, the slot 13 passes through the centre of rotation 14 of the drill 1 and forms an acute angle β to a second, axially extending, centre plane C-C of the male part 10, which second centre plane C-C is perpendicularly to the first centre plane B-B, see Fig 3. This means that the slot 13 breaks through the ends of the connection portion 11 at a distance from the centre plane C-C, see both Figs 2 and 3. This is advantageous from the point of view strength, which will be explained in more detail in connection with Fig 5.

The tool part 3 also comprises a through hole 15, which has a pitch which is parallel to the inclination of the male part 10 and the first support surface 12. Furthermore, the hole 15 has an extension, which is parallel to the extension of the slot 13, seen in planar view of the tool part 3, i.e. according to Fig 3. Thus, the longitudinal centre axis of the hole 15 forms an angle β to the second centre plane C-C, see

Fig 3, although the hole 15 is not shown in this figure. In Fig 4 is seen that the slot 13 has an axial extension a distance underneath the hole 15, the lower limiting edge of the slot 13 having a corresponding pitch in relation to the first centre plane B-B as the hole 15, the male part 10 and the first support surface 12.

As is most clearly seen in Fig 4, the hole 15 is, in the area of the ends thereof, formed with a first conical portion 16 and a second conical portion 17. In the hole 15, a screw 18 is attached having a conical head as well as an unsymmetrical, conical nut 19 co-operating with the screw 18, the screw 18 co-operating with the first conical portion 16 while the nut 19 co-operates with the second conical portion 17. The second conical portion 17 belonging to the nut 19 is in that connection formed in such a way that on co-operation with the unsymmetrical nut 19, the latter is prevented from rotating.

Thus, the conical portions 16 and 17 are intended to constitute surfaces for the screw 18 and the nut 19 to act against when the same are in engagement with each other and approach each other during tightening of said screw connection. This means that on tightening of said screw connection, the slot 13 will be widened; the significance of this will be described more in detail below in connection with the description of the function of the dovetail coupling.

As is most clearly seen in Figs 2 and 4, the cutting part 7 is provided with a female part 20 belonging to the dovetail coupling, which in principle consists of an elongated groove, which has a shape corresponding to the male part 10, i.e. the groove has a generally circular cross-section. Preferably, the female part 20 is formed as a groove that has constant internal dimensions along the entire longitudinal direction thereof. As is seen in Fig 4, the female part 20 does not extend over the entire transverse dimension of the cutting part 7 but the left end in Fig 4 of the female part 20 is

defined by a stop face 21, which has the purpose of co-operating with the left end in Fig 4 of the male part 10. Correspondingly as for the male part 10, a longitudinal centre axis 6 of the female part 20 is not perpendicular to the longitudinal direction of the tool but forms an obtuse angle α to the first centre plane B-B, see Fig 4. A second support surface 8 of the cutting part 7 surrounding the female part 20, which surface 8 in the embodiment illustrated is plane, forms a corresponding angle α to the first centre plane B-B.

In both the tool part 3 and the cutting part 7, cooling ducts are provided, the tool part 3 having an axially extending first cooling duct 22 situated in the centre of the tool part 3. The cutting part 7 has two second cooling ducts 23 diverging from the centre of the cutting part 7, which ducts port in the free end of the cutting part 7.

On interconnection of the cutting part 7 with the tool part 3, the cutting part 7 is pushed onto the tool part 3 from the left in Fig 4, i.e. the female part/groove 20 is pushed onto the male part 10 until the left end in Fig 4 of the male part 10 comes into abutment against the stop face 21 of the female part 20. Thanks to the inclination of the male part 10, the female part 20, the first support surface 12 and the second support surface 8, the stop face 21 of said cutting part 7 will be pressed against the left end of the male part 10 in Fig 4, as a result of the load which is applied to the cutting part 7 during machining with the tool according to the present invention. This design contributes, to a large extent, to the cutting part 7 taking up a correct position on the tool part 3. When the cutting part 7 has assumed the above-described position on the tool part 3, the dovetail coupling is activated. In doing so, the screw 18 is rotated in relation to the nut 19, which is prevented from rotating. This means that the screw 18 and the nut 19 approach each other, which in turn ensures that the slot 13 is widened, and a clamping of

the cutting part 7 in relation to tool part 3 takes place. In order to illustrate closer how this clamping takes place, reference is made to Fig 5. In the areas in Fig 5 designated 24, a contact between the male part 10 and the female part 20 takes place when the slot 13 is widened. The forces generated in these areas 24 are directed obliquely downwards and diverge from each other. This means that the second support surface 8 of the cutting part 7 will be pressed against the first support surface 12 of the tool part 3, which is advantageous in order for the cutting part 7 to retain the correct position on the tool part 3, since the tool according to the present invention during use is occasionally exposed to large stresses. During use of the tool, i.e. rotation of the same, the connecting portion 11 will also be exposed to stresses, the connection portion 11 represents the critical section, since this portion 11 has the smallest transverse dimension in the dovetail coupling. In order to accommodate the forces acting on the connection portion 11 in the best possible way, the slot 13 has been given an extension such that the slot, as has been pointed out above, breaks through the ends of the male part 10 at one side the centre portion of the male part 10. Thereby, a relatively large undivided first section 25 of the connection portion is formed in the two ends of the connection portion 11, said first section 25 being oriented in such a way that the same takes up the forces generated from the rotation. Beside the first section 25, a second section 26 is formed, which is substantially smaller than the first section 25.

In this connection, it should be pointed out that, in the above-described embodiment, the male part 10 abuts against the female part 20 only in the areas 24. This means that the male part 10 and the female part 20 need to have a shape corresponding to each other only in the areas 24, in other respects the shape of said parts may vary in a variety of different

ways as long as the cross-section of the male part 10 is situated within the cross-section of the female part 20.

In Fig 6, an alternative embodiment is schematically shown of the dovetail coupling between a tool part 3' and a cutting part 7'. The male part 10' has a generally circular cross-section and comprises a connection portion 11' having a smaller transverse dimension than the largest transverse dimension of the male part 10'. The male part 10' has a through hole 15' extending along the longitudinal direction thereof, which has a circular cross-section and is centrally situated in the male part 10'. In the hole 15', an out of round pin 27' is received, which is rotatable in the hole 15' but fixed in the axial direction of the male part 10'. The pin 27' is provided with a key recess 28' for rotation of the pin 27'. A slot 13' is centrally situated and extends a distance into the tool part 3'. The female part 20' has a principally similar design as the female part 20. Even if it is not seen in Fig 6, the male part 10' and the female part 20' may have the same pitch, in relation to the longitudinal direction of the tool, as the male part 10 and the female part 20. The female part 20' may also, at one end thereof, be provided with a stop face in the corresponding way as the female part 20 has a stop face 21.

The dovetail coupling according to Fig 6 works in such a way that at mounting of the female part 20' on the male part 10', which is carried out by the female part 20' being pushed onto the male part 10', the pin 27' is oriented in such a way that the smallest transverse dimension thereof extends horizontally in Fig 6. When the female part 20' is pushed onto the male part 10', the pin 27' is rotated so that the largest transverse dimension thereof assumes a horizontal position, which is shown in Fig 6. In doing so, the slot 13' will be widened and clamping of the female part 20' on the male part

10' takes place in principally the same way as in the embodiment according to Figs 1-5.

A general principle for the tool according to the present invention is that the cutting part 7; 7' is manufactured from cemented carbide, ceramics or another comparatively hard material. This has the advantage that the chips do not wear off material on the cutting part 7; 7' to the same extent as if a part of the cutting part 7; 7' was manufactured in steel. The tool part 3; 3' is manufactured from a comparatively softer material, preferably steel.

The tool according to the present invention is preferably intended for chip removing machining in metal, but it is fully possible to use the tool also for other materials in which the tool can function.

Feasible Modifications of the Invention

In the two above-described embodiments, the male part 10; 10' is situated on the tool part 3; 3' and the female part 20; 20' is formed in the cutting part 7; 7'. Clamping of the female part 20; 20' on the male part 10; 10' is provided by causing the male part 10; 10' to expand. Within the scope of the present invention, it is, however, conceivable that the male part is situated on the cutting part and that the female part is formed in the tool part. In doing so, a slot is arranged adjacent to the female part. Clamping of the male part in the female part takes place by the female part being squeezed around the male part, in which this clamping may, for instance, take place with a through screw connection in the tool part adjacent to the slot.

In the embodiment according to Figs 1-5, the expanding member consists of a screw connection 18, 19 while in the embodiment according to Fig 6 the expanding member consists of a pin 27' with an out of round cross-section. However, within the scope of the present invention, it is conceivable that the

pin 27' with the out of round cross-section constitutes an expanding member in the embodiment according to Figs 1-5 and that the screw connection 18, 19 constitutes an expanding member in the embodiment according to Fig 6. It is also possible to use other expanding members within the scope of the present invention.

Above, it has been stated that the cutting part 7; 7' should be manufactured in a hard material, the cutting part 7; 7' preferably being solid in the material in question. However, within the scope of the present invention, it is also feasible that the cutting part is manufactured from a compound-material, i.e. that the surface layer consists of a hard material while the core consists of a softer material.

In Fig 1 is seen that the tool part 3 and the cutting part 7 are provided with helicoidal chip channels 9. Within the scope of the invention, it is, however, conceivable that the chip channels are straight and extend in the axial direction of the tool.

Claims

1. Rotatable tool having a replaceable cutting part (7; 7') at the chip removing free end of the tool, the tool also comprises a tool part (3; 3'), on which the cutting part (7; 7') is intended to be mounted, that the tool part (3; 3') and the cutting part (7; 7') have chip channels (9), that the cutting part (7; 7') has member for chip removing machining, and that the tool part (3; 3') and the cutting part (7; 7') are interconnected by means of a dovetail coupling which comprises a male part (10; 10') and a female part (20; 20'), c h a r a c t e r i z e d in that the dovetail coupling comprises members (15, 18, 19; 15', 27') for providing a mutual clamping of the parts (10, 20; 10', 20') included in the dovetail coupling.

2. Tool according to claim 1, the male part (10; 10') being attached to the tool part (3; 3') and the female part (20; 20') being received in the cutting part (7; 7'), c h a r a c t e r i z e d in that the male part (10; 10') is provided with a slot (13; 13') which extends along the entire length of the male part (10; 10') as well as extending in the axial direction of the tool part (3; 3'), and that the tool has members (15, 18, 19; 15'; 27') for expansion of the male part (10; 10').

3. Tool according to claim 2, c h a r a c t e r i z e d in that the slot (13) forms an acute angle (β) with an axial centre plane C-C of the male part (10).

4. Tool according to claim 2 or 3, c h a r a c t e r i z e d in that the members for expanding the male part (10) comprise a through hole (15) recessed in the tool part (3) adjacent to

the slot (13), a screw connection (18, 19) received in the hole (15), which at tightening widens the slot (13).

5. Tool according to claim 4, c h a r a c t e r i z e d in that the hole (15) is conical in the area of the ends thereof, that a screw (18) included in the screw connection has a conical head, and that a nut (19) included in the screw connection is conical.

6. Tool according to any one of the preceding claims, c h a r a c t e r i z e d in that a longitudinal centre line (4) of the male part (10; 10') and a longitudinal centre line (6) of the female part (20; 20') form an obtuse angle (α) to an axially extending centre plane (B-B) of the tool, the angle (α) being in the interval $90° < \alpha < 120°$.

7. Tool according to any one of the preceding claims, c h a r a c t e r i z e d in that one end of the female part (20; 20') is defined by a stop face (21), and that one end of the male part (10; 10') is displaced from the periphery of the tool part (3; 3').

8. Cutting part (7; 7') intended to constitute a replaceable part at a chip removing free end of a rotatable tool, the cutting part (7; 7') having members (20; 20') to be included in a dovetail coupling, c h a r a c t e r i z e d in that a female part (20; 20') is received in the cutting part (7; 7'), and that the cutting part is manufactured from cemented carbide, ceramics or another comparatively hard material.

9. Cutting part (7; 7') according to claim 8, c h a r a c t e r i z e d in that one end of the female part (20; 20') is defined by a stop face (21).

10. Cutting part (7; 7') according to claim 8 or 9, c h a r a c t e r i z e d in that a longitudinal centre line (6) of the female part (20; 20') forms an obtuse angle (α) to an axially extending centre plane (B-B) of the cutting part (7; 7'), the angle (α) being in the interval $90° < \alpha < 120°$.

Fig. 1

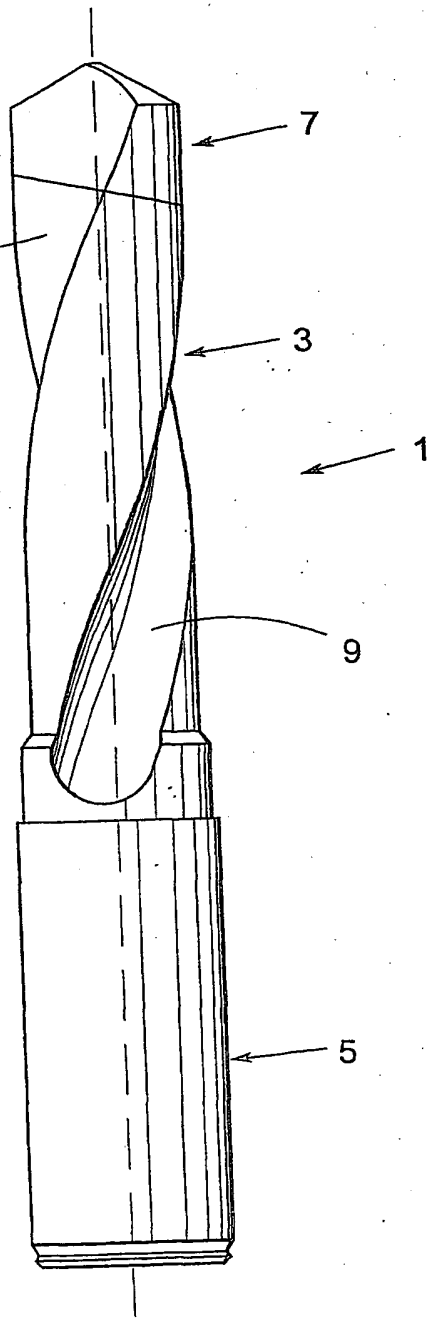


Fig. 2

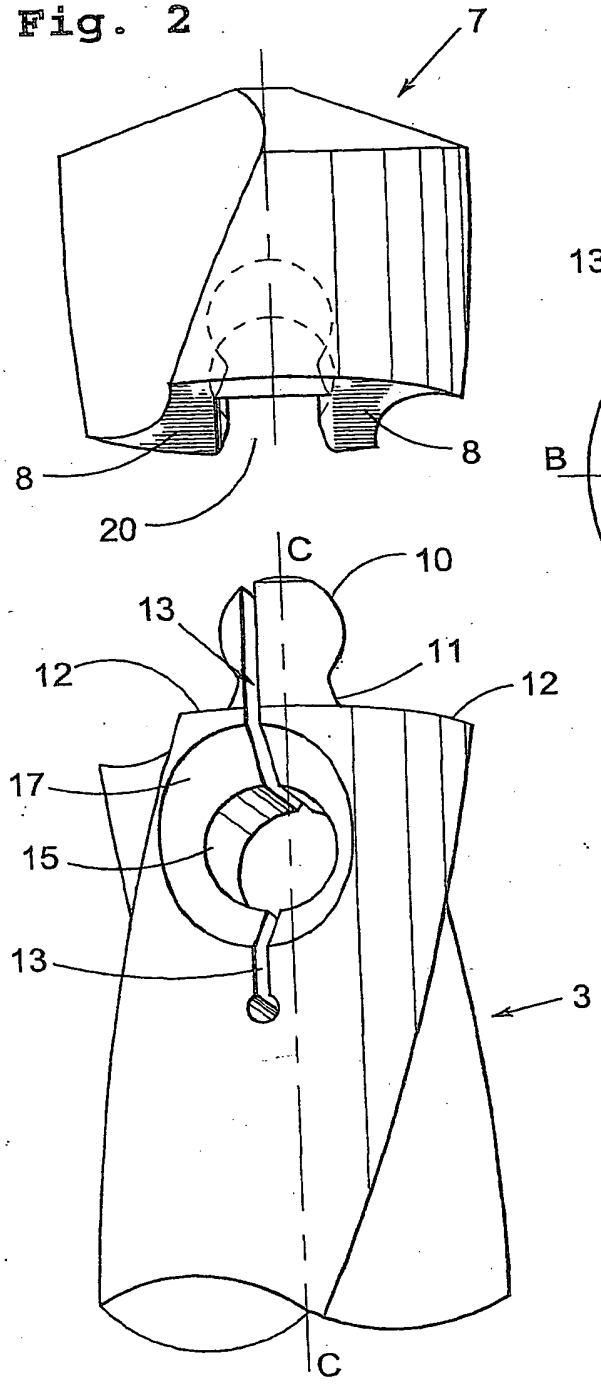


Fig. 3

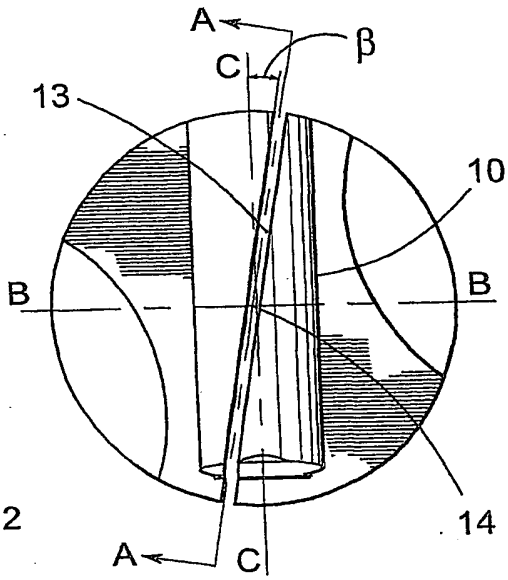


Fig. 4

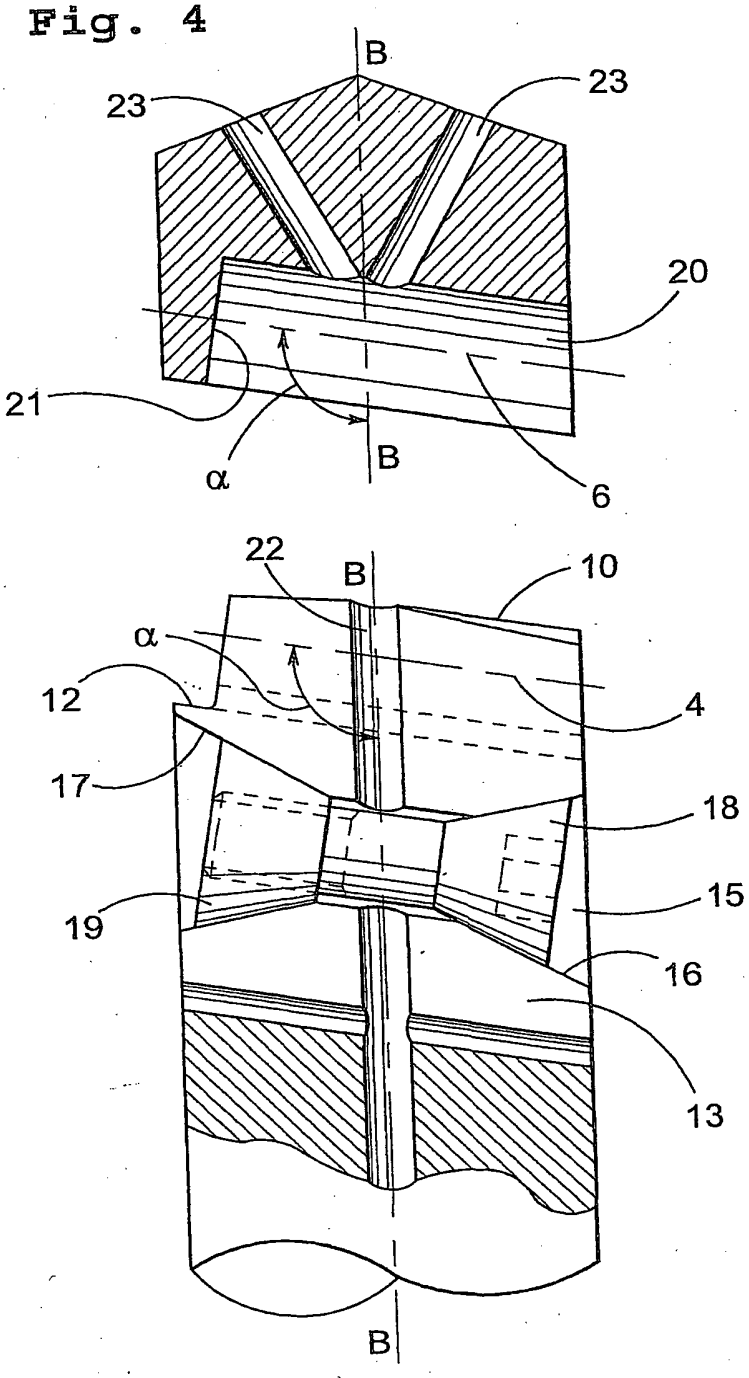


Fig. 5

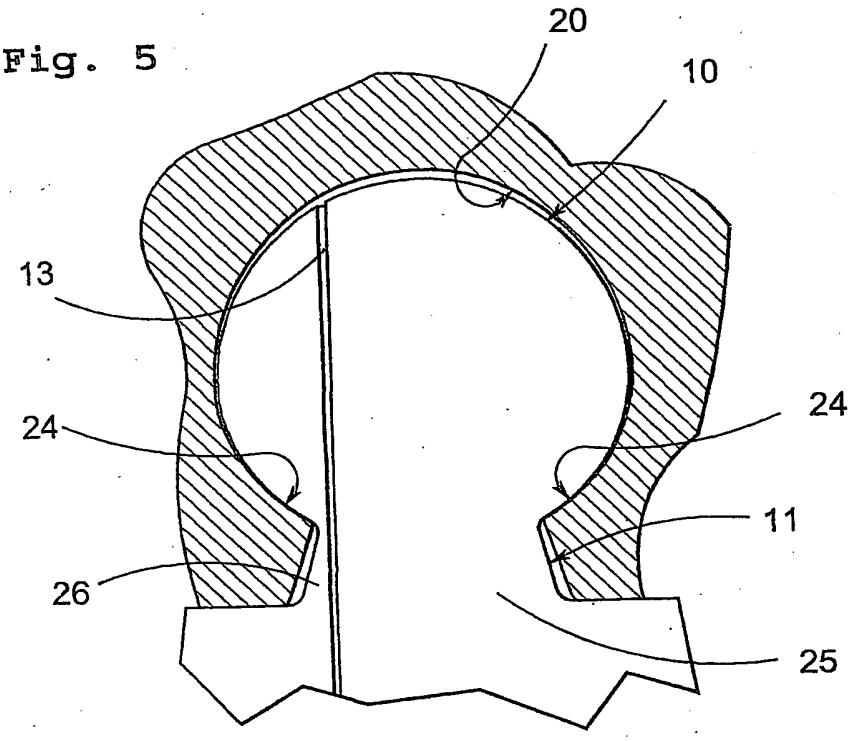
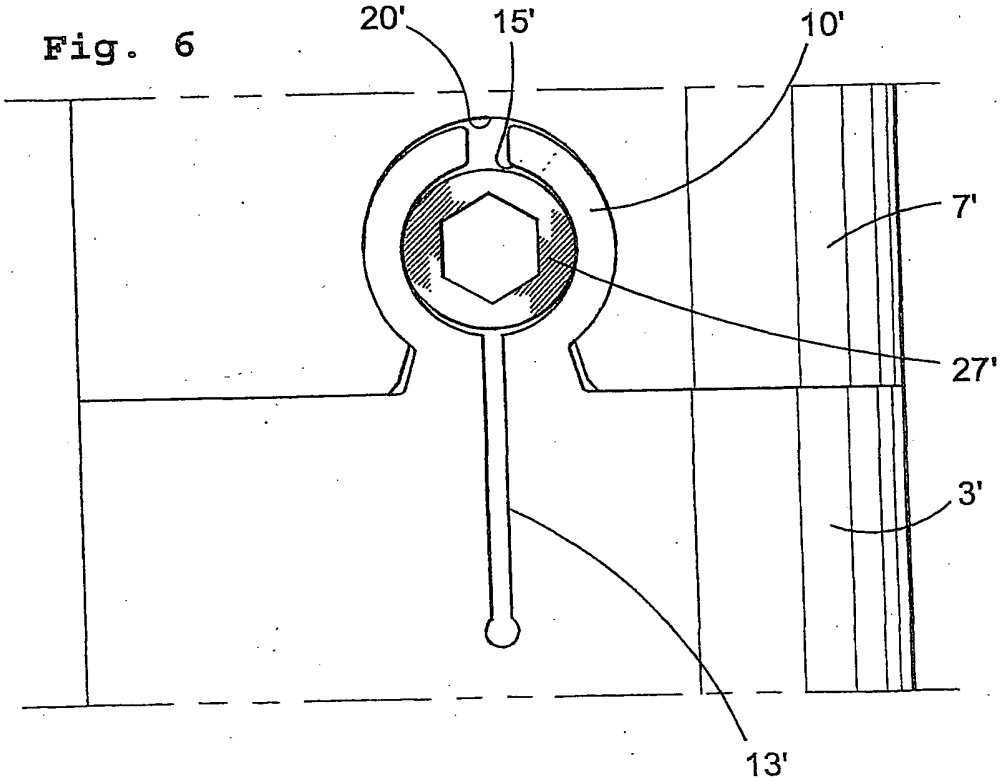


Fig. 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/02318

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B23B 51/00 // B23C 5/20
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B23B, B23C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 3230688 A1 (CARL HURTH MASCHINEN- UND ZAHNFABRIK GMBH & CO), 23 February 1984 (23.02.84), figure 2, abstract	1,7,8,9
A	--	2-6,10
X	US 5769577 A (BODDY), 23 June 1998 (23.06.98), figure 7, abstract	8,9
A	--	1-7,10
X	DE 367010 C (GEORG SAMUEL), 15 January 1923 (15.01.23), figures 1-3, claim 1	1,6-10
A	--	2-5

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 January 2002	29-01-2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Fredrik Strand/ELY Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/02318

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	Patent Abstracts of Japan, abstract of JP 1-113406 A (MST CORPORATION:KK), 24 April 2001 (24.04.01)	1,7,8,9
P,A	--	2-6,10
P,X	WPI/Derwent's abstract, Accession Number 2001-436796 week 0147, ABSTRACT OF JP, 2001150220 (OSG KK) 5 June 2001 (05.06.01), figure 3	1,7,8,9
P,A	--	2-6,10
P,X	JP 2001150220 A (OSG KK), 5 June 2001 (05.06.01)	
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A	US 5957631 A (HECHT), 28 Sept 1999 (28.09.99), figure 1, abstract	1-10
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE01/02318

Box I **Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II **Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

The separate inventions are:

Claims 1-7 are directed to a rotatable tool having a replaceable cutting part with a dovetail coupling.
Claims 8-10 is directed to the choice of material of the cutting part.

The above groups of inventions do not satisfy the requirements of unity of invention. The groups of inventions are not so linked as to form a single general inventive concept (PCT Rule 13.1 and 13.2).
The "special technical features" in group one relate to a rotatable tool having a replaceable cutting part with a dovetail coupling between the tool part and the cutting part.
The "special technical features" in group two relate to the choice of material of the cutting part and to the geometrical shape of the cutting part.

There is no technical relationship among these inventions involving one or more of the same or corresponding technical features.

INTERNATIONAL SEARCH REPORT

Information on patent family members

27/12/02

International application No.
PCT/SE 01/02318

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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